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REMARKS**I. Rejections under 35 U.S.C. §103**

The rejection of claims 1 – 7, 9 – 12, 16, and 18 under 35 USC 103(a) over Harrison et al, US 5,292,428 is respectfully traversed. Applicants have unexpectedly found that the amount of polynuclear aromatics in a distillate fuel product can be substantially reduced by limiting the hydrogen portion of the treat gas in the second hydrodesulfurization stage to less than or equal to three times the chemical hydrogen consumption.

Polynuclear aromatic compounds, also referred to as PNAs, are an undesirable species in a distillate fuel product such as diesel. As noted on page 14 of the specification as filed, PNAs are aromatic compounds that have two or more aromatic rings. PNAs contribute significantly to the emissions produced by diesel engines, and therefore it is desirable to reduce the amount of PNAs present in a diesel fuel.

Unfortunately, conventional methods of hydrotreatment are not selective for removing PNAs relative to other aromatic compounds. Attempting to simply hydrogenate all aromatics within a distillate fuel product would lead to a large level of hydrogen consumption. Such a level of hydrogen consumption would substantially increase the cost of production for a distillate fuel product.

The claimed invention provides a method for balancing these competing interests. By maintaining a hydrogen concentration in a second hydrotreatment stage as described in the claims, the level of PNAs within a distillate fuel product can be reduced without excessive hydrogen consumption. A convenient metric for

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understanding whether PNAs have been reduced without excessive hydrogen consumption is to determine the ratio of total aromatics to PNAs within the resulting distillate fuel product. If PNAs remain high, this ratio will have a low number. On the other hand, if aromatics are indiscriminately hydrogenated, this ratio will also have a low number. A high ratio value is only achieved by reducing the number of PNAs while minimizing the hydrogenation of other aromatics.

The benefits of the invention can be understood based on the data contained in Tables 1 and 2. Table 1 presents product properties for feeds processed according to the invention. For each product in Table 1, a distillate fuel product is produced with a total sulfur level below 100 wppm and a ratio of aromatics to PNAs of greater than 13. By contrast, Table 2 provides comparative examples of distillate fuel products produced by other methods. The highest ratio of aromatics to PNAs in Table 2 is 10.45, for the process used in Comparative Example C.

The distinction between the claimed invention and the Comparative Examples is readily seen in Table 2. Table 2 plots the ratio of aromatics to PNAs for each of the inventive examples from Table 1 and each of the Comparative Examples from Table 2.

The Harrison reference provides no discussion of a distinction between PNAs and other aromatic compounds. Therefore, Harrison fails to even identify the problem of reducing the amount of PNAs preferentially to other aromatic compounds. Additionally, Harrison also does not have any discussion or suggestion of limiting hydrogen consumption in the second hydrotreatment stage as required by the claimed invention. Therefore, Harrison also fails to identify the process conditions required to achieve the beneficial effects of the claimed invention.

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The Examiner has previously noted Col. 10, lines 3 – 11 of Harrison, where Harrison states that it is preferred to use at least 1.05 times the stoichiometric amount of hydrogen during the hydrogenation process described in Harrison, and that some additional allowance should be made for hydrogen dissolved in a recovered treated feedstock. This is merely a statement that enough hydrogen must be present allow the hydrogenation reaction to stoichiometrically occur, and provides no insight into the benefits of controlling the amount of hydrogen available during hydrotreatment.

As further evidence that Harrison does not describe or suggest the process or the benefits of the claimed invention, the Examples in Harrison do not meet the requirements of the claimed invention. In particular, the Examples in Harrison do not describe or suggest introducing no more than 3 times the stoichiometrically required amount of hydrogen into the second stage.

In all of the Examples (including the Comparative Example), Harrison uses a feed rate of 515 ml/hr, as shown in Table 2. The difference in the aromatic vol.% between line 222 and line 247 is always less than 5 vol.% in Table 3. Thus, the second reactor stage in Harrison is hydrogenating no more than 5 vol.% of aromatics, or at least 25.8 ml of aromatics per hour. In order to convert this to a weight, we can use the density given in Table 1 of 944 kg/m³, which is equivalent to 944 g/liter. Using this conversion, 25.8 ml/hr of aromatics corresponds to 24.4 g/hr of aromatics. In order to estimate the hydrogen consumption, all of the aromatics can be treated as benzene, which requires consumption of 6 hydrogen atoms or 3 hydrogen molecules to fully hydrogenate. 24.4 g/hr of benzene corresponds to about 0.31 moles of benzene per hour. Thus, in order to saturate the aromatics in Harrison, 0.93 moles of hydrogen per hour would be needed stoichiometrically. Note that the amount of hydrogen required for sulfur removal will be small compared to the nitrogen. The largest amount of sulfur removal

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indicated in the second stage of Harrison is about 2000 wppm, or about 0.2 wt%. For a flow rate of 515 ml/hr at a density of 944 g/liter, 0.2 wt% of sulfur removal corresponds to removal of about 1 gram per hour, or much less than 0.05 moles of hydrogen per hour stoichiometrically. Based on the above calculations, the highest stoichiometric consumption required in Harrison is less than 1 mole of molecular hydrogen per hour.

By contrast, the feed rates of hydrogen in Harrison are all substantially greater than 3 moles of hydrogen per hour. Example 5 in Harrison has the lowest H₂ flow rate of 119 Normal liters per hour. As described in Harrison, all of this hydrogen is introduced into the second reaction stage. Harrison does not indicate whether the normal conditions correspond to 0°C or 25°C. However, under either condition, 119 liters per hour of gas corresponds to roughly 5 moles per hour of gas. Thus, even in the lowest H₂ flow rate described in Harrison, the ratio of hydrogen provided into the second reaction stage relative to the consumption in the second stage is about 5 to 1, substantially higher than the claimed requirement of having 3 times or less hydrogen in the second stage relative to consumption.

As further shown by the Examples, Harrison does not describe or suggest the requirement of the claimed invention of limiting the hydrogen portion of the treat gas in the second stage to 3 times or less the chemical hydrogen consumption. Because Harrison fails to describe or suggest this claimed requirement, as well as failing to describe or suggest the unexpected benefit produced by practicing the claimed invention, claims 1 – 7, 9 – 12, 16, and 18 are patentable in view of Harrison. Reconsideration and withdrawal of the rejection are respectfully requested.

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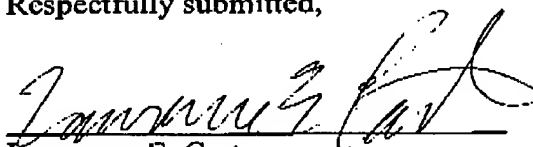
II. Conclusion

Having demonstrated that all rejections of claims have been overcome, this application is in condition for allowance. Accordingly, applicants request early and favorable reconsideration in the form of a Notice of Allowance.

If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated, since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response. Please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1330.

Respectfully submitted,



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☒ Pursuant to 37 CFR 1.34(a)

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